USDA

United States Department of Agriculture

January 7, 2015

NATIONAL ENGINEERING HANDBOOK PART 650
ENGINEERING FIELD HANDBOOK
NOTICE 210-WI-132

This notice provides revisions to the Wisconsin Supplements in Chapter 2.

Filing Instructions:

Remove:
Existing Tabulation Sheets
Pages: 2-WI-1 and 2
Page: 2-WI-42a

Insert:
New Tabulation Sheets
Pages: 2-WI-42a to 2-WI-42c
Pages: WI-1 to WI-16 *(following the national chapter)*

Wisconsin supplements and transmittal notices for the EFH can be found on the Wisconsin NRCS web site at http://www.nrcs.usda.gov/wps/portal/nrcs/detail/wi/technical/engineering/.

JIMMY BRAMBLETT
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Attachments

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DIRECTIVE TABULATION SHEET

Title No. 210

Directive Name/Type: National Engineering Handbook Part 650
Engineering Field Handbook
Wisconsin Supplements

Directive Number	Issue Date	Part, Subpart, Pages, etc., or Bulletin Subject
WI-1	8/1/1972	Superseded by WI-127.
WI-5	4/6/1978	Canceled by WI-76.
WI-7	6/1/1978	Superseded by WI-76.
WI-10	7/12/1978	Canceled by WI-77.
WI-13	4/8/1980	Superseded by WI-127.
WI-15	9/30/1980	Superseded by WI-127.
WI-19	6/7/1982	Superseded by WI-102.
WI-23	3/30/1983	Canceled by WI-78.
WI-26	11/30/1983	Superseded by issue of April 2001 version of Chapter 14 (page 14-WI-110a).
WI-27	12/27/1983	Canceled by WI-78.
WI-29	9/6/1984	Superseded by WI-81.
WI-30	9/19/1984	Superseded by WI-106.
WI-33	2/11/1985	Superseded by WI-102.
WI-35	4/8/1986	Superseded by WI-73.
WI-36	7/3/1986	Superseded by WI-106.
WI-37	2/9/1987	Superseded by WI-106.
WI-39	1/19/1988	Superseded by WI-89.
WI-40	3/1/1988	Canceled by WI-76.
WI-41	3/9/1988	Superseded by WI-87.
WI-43	9/14/1988	Canceled by WI-78.
WI-45	6/7/1989	Concrete Block Lined Chute, Chapter 6, pages 6-WI-43 to 6-WI-49.
WI-46	6/26/1989	Canceled by WI-115.
WI-47	8/30/1989	Superseded by WI-77.
WI-48	10/4/1989	Revised Chapter 2, Estimating Runoff and Peak Discharge.
WI-49	1/9/1990	Canceled by WI-76.
WI-50	6/1/1990	Superseded by WI-120.
WI-51	6/21/1990	Superseded by WI-106.
WI-54	10/23/1990	Superseded by WI-73.
WI-55	11/19/1990	Superseded by WI-67 and WI-76.
WI-56	4/9/1991	Superseded by WI-73.
WI-57	4/29/1991	Superseded by WI-73.
WI-58	6/12/1991	Superseded by WI-128.
WI-59	6/12/1991	Dam Breach Studies, Chapter 11, pages 11-WI-29 to 32.
WI-60	7/15/1991	Dam Breach Studies, Chapter 11, corrected pages 11-WI-27 and 28.

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Directive Number	Issue Date	Part, Subpart, Pages, etc., or Bulletin Subject
WI-61	11/26/1991	Superseded by WI-73.
WI-62	11/17/1992	Dispersive Soils, Lab Sample Sizes and Preparation of Requests for Soil Mechanics Testing, Chapters 4, pages 4-WI-49 to 68, 4-WI-iii. (Chapter 17, page 17-WI-17, superseded by WI-106.)
WI-63	8/31/1992	Superseded by WI-106.
WI-65	4/21/1993	Superseded by WI-77.
WI-66	5/10/1993	Superseded by WI-122.
WI-67	2/9/1994	Canopy Inlet Dimensions add page 6-WI-52a.
WI-68	3/31/1995	Superseded by WI-73.
WI-69	5/12/1995	Superseded by WI-73.
WI-70	5/30/1995	Superseded by WI-106.
WI-71	7/17/1995	Superseded by WI-73.
WI-72	2/2/1996	Superseded by WI-109.
WI-73	5/10/1996	Superseded by WI-89.
WI-74	7/8/1996	Canceled by WI-77.
WI-75	9/4/1996	Superseded by WI-89.
WI-76	4/7/1997	Revised Chapter 11 Amendments for Earth Spillways.
WI-76A	5/13/1997	Chapter 11, pages 11-WI-7 & 8, 11-WI-11 &12, 11-WI-15 & 16.
WI-77	6/23/1997	Chapter 3, pages 3-WI-42a to 42q; Chapter 16, pages 16-WI-1 to 133. (Chapter 17, pages 17-WI-92 and 92 superseded by WI-106.) Chapter 18, page 18-WI-24a and 34a.
WI-78	6/27/1997	Chapter 11, page 11-WI-55, Detention Basin Routing. Chapter 17 material superseded by WI-106.
WI-79	8/27/1997	Superseded by WI-89.
WI-80	9/30/1997	Superseded by WI-89.
WI-81	4/7/1998	Chapter 6, pages 6-WI-1 through 6-WI-10, Design Procedures and Criteria for Toewall drop Spillways.
WI-82	4/8/1998	Superseded by WI-106.
WI-83	11/17/1998	Superseded by WI-89.
WI-84	3/15/1999	Superseded by WI-104.
WI-85	5/5/1999	Superseded by WI-96.
WI-86	7/26/1999	Change WI-84 dated 5/5/99 to WI-85 and replace Chapter 13 with new revised chapter 13. New revised Chapter 13.
WI-87	11/29/1999	Superseded by WI-122.
WI-88	01/13/2000	Superseded by WI-90.
WI-89	01/20/2000	Superseded by WI-106.

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Directive Number	Issue Date	Part, Subpart, Pages, etc., or Bulletin Subject
WI-90	02/03/2000	Superseded by WI-129.
WI-91	06/13/2000	Superseded by WI-106.
WI-92	07/13/2000	Chapter 16, Page 16-WI-95. Correction of previously issued page.
WI-93	11/14/2000	Superseded by WI-98.
WI-94	11/27/2000	Superseded by WI-106.
WI-95	04/02/2001	Superseded by WI-97.
WI-96	04/03/2001	Superseded by WI-109.
WI-97	04/26/2001	Superseded by WI-110.
WI-98	4/30/2001	Superseded by WI-106.
WI-99	5/29/2001	Superseded by WI-106.
WI-100	6/26/2001	Superseded by WI-105.
WI-101	10/01/2001	Superseded by WI-106.
WI-102	11/05/2001	Superseded by WI-112.
WI-103	01/31/2002	Superseded by WI-121.
WI-104	05/03/2002	Superseded by WI-118.
WI-105	6/10/2003	Superseded by WI-106.
WI-106	5/3/2004	Chapter 17, Complete Revision, pages 17-WI-i to 17-WI-92 (partially revised by WI-117, WI-123, and WI-130).
WI-107	8/2/2004	Superseded by WI-130.
WI-108	9/22/2004	Superseded by WI-111.
WI-109	1/31/2005	Superseded by WI-113.
WI-110	3/15/2005	Superseded by WI-111 and WI-120.
WI-111	5/2/2006	Superseded by WI-130.
WI-112	6/15/2006	Chapter 6, Pages 6-WI-25 to 34. Correct units used in calculations and update DOT rock gradations.
WI-113	7/6/2006	Chapter 4, Pages 4-WI-63 to 67. Revised guidance and ASTM references for SML requests.
WI-114	2/16/2007	Superseded by WI-121.
WI-115	12/20/2007	Chapter 7, page 7-WI-12a removed. The entire chapter was replaced by NHQ.
WI-116	6/2/2008	Chapter 17, pages 17-WI-61 to 70.
WI-117	8/6/2008	Superseded by WI-130.
WI-118	8/22/2008	Chapter 4, pages 4-WI-68 to 70. (Revised by WI-127) Chapter 12, page 12-WI-68.
WI-119	2/23/2009	Chapter 16, pages 16-WI-i to 49, Companion Documents 580-1 to 580-14.
WI-120	3/11/2009	Superseded by WI-132.
WI-121	1/20/2011	Chapter 19, pages 19-WI-1 to 20. Scope and Effect Equations.

DIRECTIVE TABULATION SHEET

Title No. 210

Directive Name/Type: National Engineering Handbook Part 650
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Directive Number	Issue Date	Part, Subpart, Pages, etc., or Bulletin Subject
WI-122	8/26/2011	Chapter 4, pages 4-WI-61 & 62. Sample sizes for soil mechanics tests. Chapter 12, pages 12-WI-55 to 59. Pipeline planning guidance. (Superseded by WI-131) Chapter 14, page 14-WI-1. Minimum distances to maintain between trees and drains. Chapter 16, pages 16-WI-28. Rock riprap testing and gradation. Chapter 16, Companion Document 580-15. Stream Habitat Development. Chapter 17, pages 17-WI-67 & 68. Requirements for woven/nonwoven geotextiles.
WI-123	9/7/2011	Superseded by WI-125, WI-126, and WI-130.
WI-124	9/22/2011	Superseded by WI-130.
WI-125	10/6/2011	Chapter 3, pages 3-WI-42r & 42s. Typical Values for Manning's n.
WI-126	11/5/2012	Superseded by WI-128 and WI-130.
WI-127	11/14/2012	Chapter 4, pages 4-WI-69 to 4-WI-71. Soil Investigations. Chapter 8, Pages 8-WI-100(1) to 8-WI-100(9) and Exhibit 8-6 (Remove)
WI-128	10/22/2013	Chapter 6, remove pages 6-WI-51 to 80. Chapter 17, insert pages 17-WI-73 and 74. Nonstructural concrete slab reinforcement using the Subgrade Drag Equation.
WI-129	1/6/2014	Chapter 1, remove and replace pages 1-WI-1 to 3.
WI-130	2/6/2014	Chapter 17, remove pages 17-WI-75 to 98 (all pre-engineered waste storage facilities or components).
WI-131	3/31/14	Chapter 12, replace pages 12-WI-55 to 59. Pipeline design.
WI-132	1/7/2015	Chapter 2, replace existing supplements.

Hydrologic Soil Groups

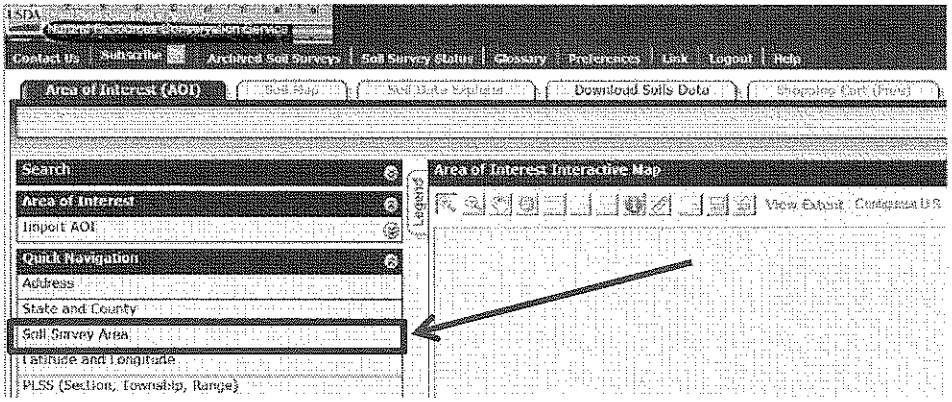
The hydrologic soil group classifications shown in Table 2-1 on pages 2-42 through 2-83 are obsolete and should not be used. Hydrologic soil group classifications can vary by location. Soils with the same map unit name, but located in different counties, may have different hydrologic soil group classifications. Current hydrologic soil group classifications (ratings) for the applicable county should be obtained from the **NRCS Web Soil Survey** as shown below.

Retrieving Hydrologic Soil Group Data from the NRCS Web Soil Survey:

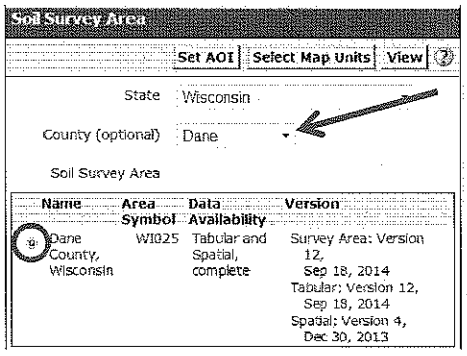
Navigate to the NRCS web soil survey: http://websoilsurvey.nrcs.usda.gov/app/
(or Google NRCS Web Soil Survey)

Select the Green "**Start WSS**" Button: 

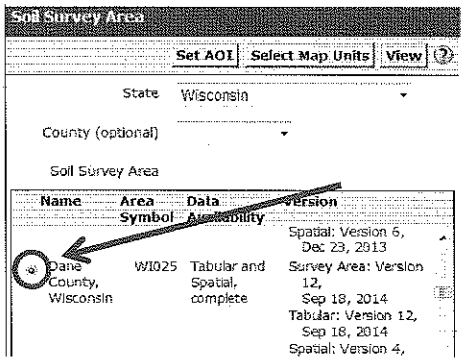
On the left side of the screen navigate to and select "**Soil Survey Area**":



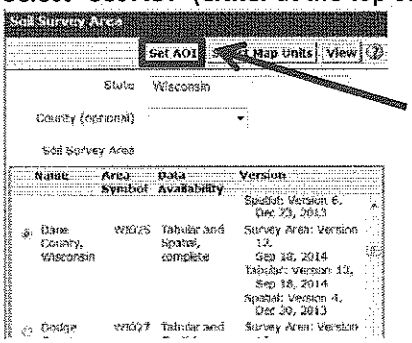
Make **State** selection. Make **County** selection ***and*** click radial button next to the applicable County. **Or** just select the radial button next to the applicable County (if needed, scroll down to find County):



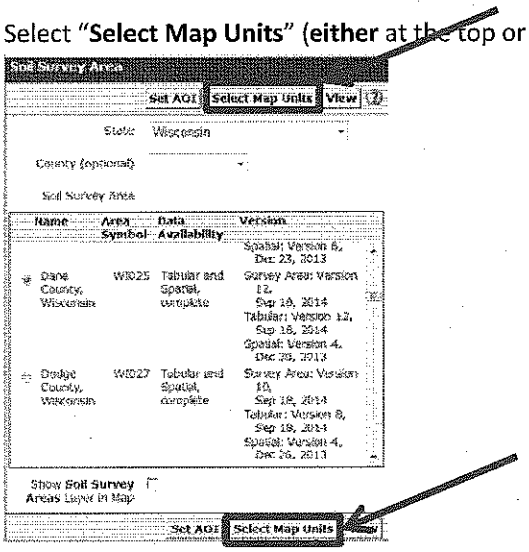
Or:



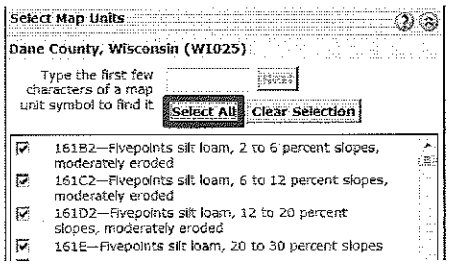
Select "**Set AOI**" (**either** at the top or the bottom of the Soil Survey Area Section):



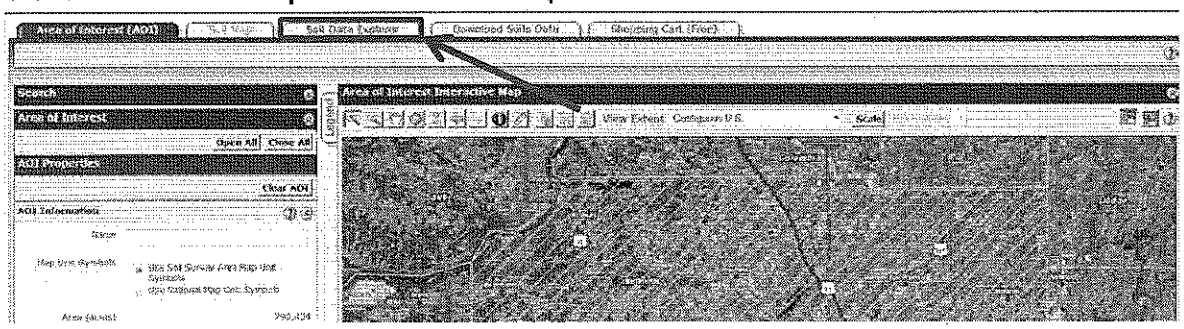
Select "**Select Map Units**" (**either** at the top or the bottom of the Soil Survey Area Section):



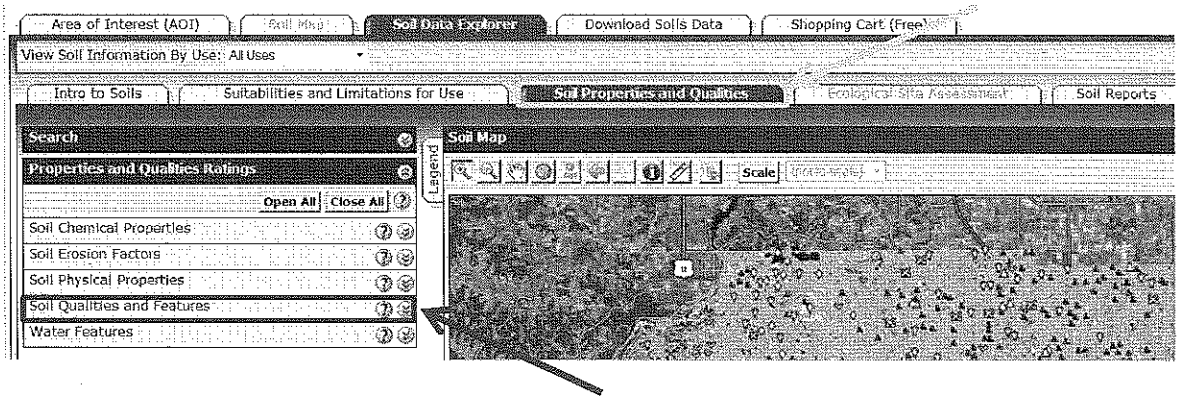
Check the box(es) next to the applicable Map Units, or click on "**Select All**":



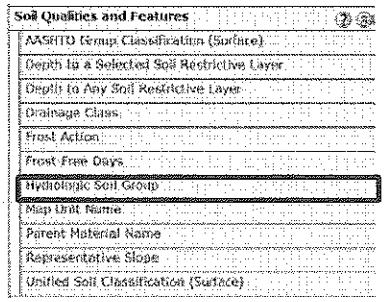
Click on the "**Soil Data Explorer**" Tab near the top of the screen:



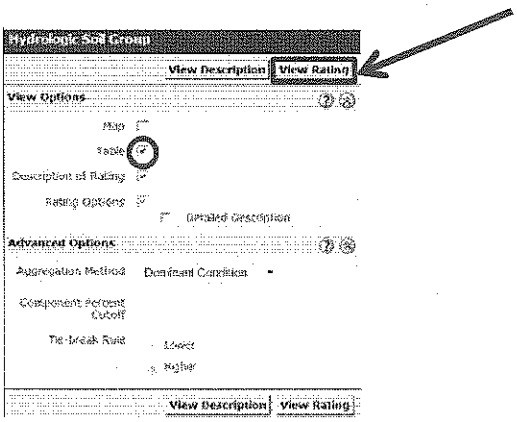
Click on the "**Soil Properties and Qualities**" Tab, located below the Soil Data Explorer Tab. Then, navigate to the left side of the screen and select "**Soil Qualities and Features**":



Select "**Hydrologic Soil Group**":



Select "**View Rating**" and be sure there is a check next to "Table" in order to obtain a table of Hydrologic Soil Group (Rating Column) for each selected Soil Map Unit. If "Description of Rating" or "View Description" is selected, a description will be given of the hydrologic soil group ratings (Classes).



WI 650.290 Purpose of Wisconsin Supplement

The purpose of this supplement is to assist Field, Area and State Office staff in using the most currently available rainfall data, National Oceanic and Atmospheric Administration (NOAA) Atlas 14, for the design of conservation practices. This supplement updates the rainfall depths, and rainfall distributions to be used in estimating runoff and peak discharges as described in NEH Part 650, Engineering Field Handbook Chapter 2 (EFH-2). This supplement also updates the rainfall databases that are used by the NRCS computer program, EFH-2.

This supplement describes the implementation process, the technical background, and gives an example application of the NOAA Atlas 14 rainfall data in the EFH-2 computer program.

WI 650.291 Implementation of Wisconsin Supplement

Effective upon receipt, NRCS Wisconsin Field, Area and State Office staff are to use the updated NOAA Atlas 14 rainfall depths and rainfall distributions when estimating runoff and peak discharges as described in NEH 650, Chapter 2. The implementation of this Supplement includes three steps:

(1) Updating NEH 650, Chapter 2 for Wisconsin: The methods and data described in this supplement supersede any applicable methods and data from NEH 650, Chapter 2 for Wisconsin. The NOAA Atlas 14 derived rainfall table in Appendix 1 and the NRCS Wisconsin Rainfall Distribution Regions map in Figure WI 2-1 supersede all rainfall data given in previous Wisconsin Supplements to NEH 650, Chapter 2. The NOAA Atlas 14 derived rainfall data in Appendix 1 replace the rainfall depths from Weather Bureau Technical Paper 40 (TP-40). The two new NRCS rainfall distribution types (MSE3 and MSE4) in Figure WI 2-1 and listed by county in Appendix 1 replace the NRCS Type II rainfall distribution.

(2) Updating the Rainfall Data Files for the EFH-2 Computer Program: Implementation of precipitation updates in the EFH-2 computer program requires replacement of the rainfall database (**COUNTY.WI**), and rainfall distribution types file (**type.rf**). The procedure for loading and replacing these EFH-2 computer program files, along with the hydrologic soil group file (**SOILS.HG**) is included in Appendix 2. An example application of the EFH-2 Computer Program is included in Appendix 3. The **COUNTY.WI**, **type.rf** and **SOILS.HG** databases are available on the NRCS Wisconsin Engineering website (scroll down to "Engineering Tools" and select "Hydrology, Hydraulics, Climate and Wetland Resources"): http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/engineering/

(3) Use of Updated Wisconsin EFH-2 and TR-55 Spreadsheets (if Applicable): Implementation of precipitation updates in the Wisconsin EFH-2 spreadsheet ("Peak Discharge, EFH Chapter 2 Method") and the Wisconsin "TR-55 Peak Runoff Calculation" spreadsheet require downloading and using the new spreadsheets from the NRCS Wisconsin Engineering website (scroll down to "Engineering Tools" and select "Hydrology, Hydraulics, Climate and Wetland Resources"): http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/engineering/

WI650.292 Technical Background

NOAA's National Weather Service (NWS) released Volumes 8 and 9 of Atlas 14 for the Midwest and Southeast United States, respectively, on April 22, 2013. Volumes 8 and 9 are the first comprehensive precipitation-frequency analyses for these regions since Technical Paper No. 40 (TP-40), "Rainfall Frequency Atlas of the United States" was completed in 1961. NOAA used precipitation measurements from rainfall stations for dates up through October 2011, where available, to perform their precipitation-duration-frequency analyses. They also updated some stations through December 2012. The period of record used for TP-40 ended in 1958. The addition of approximately 53 years of precipitation data in the NOAA Atlas 14 analyses resulted in some changes in precipitation-duration-frequency values versus those given in TP-40.

The NRCS National Water Quality and Quantity Technology Development Team (WQQT)[1] and hydraulic engineers in the respective NRCS State Offices had completed considerable study of the previously released NOAA Atlas 14 data for the Ohio Valley and neighboring states (NOAA Atlas 14, Volume 2, 2006). They developed procedures to prepare rainfall databases for the EFH-2 and WinTR-55 computer programs. They also developed rainfall distributions to replace the NRCS Type II and III distributions, which were previously used in that region. Similar procedures were used in the Midwest and Southeast states (which border the Ohio Valley NOAA 14 area) due to similar climatic and topographic characteristics.

(a) Rainfall Depth

The NRCS EFH-2 and WinTR-55 hydrology computer programs have rainfall databases that include rainfall depths by county. In order to generate the rainfall depths by county for these rainfall databases, the WQQT downloaded the NOAA Atlas 14 24-hour duration rainfall depths by storm frequency in GIS format from the NOAA Atlas 14 Precipitation Frequency Data Server. They used State and County shapefiles to overlay the precipitation layer, and used the GIS Spatial Analyst command "Zonal Statistics as Table" to generate tables of minimum, maximum, range (maximum – minimum), mean and standard deviation of the 24-hour duration rainfall depths by county. The Wisconsin NRCS engineering staff decided that the County **mean** rainfall depths were most appropriate for use in the design of conservation practices in Wisconsin. Representative county locations were then determined from the NOAA 14 GIS grid for use in developing the EFH-2 and WinTR-55 rainfall databases. The selected representative location for each county has a 100-year, 24-hour rainfall depth equal to the mean value for the county. The 1-, 2-, 5-, 10-, 25- and 50-year, 24-hour rainfall depths were also checked for the representative location, and these rainfall depths were within -1% and +1.9 % of the respective mean depths. The 24-hour rainfall depths for the representative county locations are listed in Appendix 1 of this Supplement. These rainfall depths are incorporated into the rainfall database (**COUNTY.WI**) for use

[1] The NRCS National Water Quality and Quantity Technology Development Team (WQQT) in Beltsville Maryland is a part of the NRCS West National Technology Support Center (WNTSC).

with the EFH-2 computer programs. These rainfall depths have also been included in the WinTR-55 computer program and in the Wisconsin EFH2 and TR55 spreadsheets.

If a site specific rainfall estimate is desired, data may be downloaded directly from the NOAA Atlas 14 website. However, due to the potential significant variability of the rainfall data spatially on the NOAA website, it is important to be cautious that the precipitation data be representative of the applicable drainage area. Instead of selecting the precipitation for one location, the preferred method would be to use GIS to compute a mean (or maximum) rainfall value for the drainage area. Data are available for specific locations from the NOAA Atlas Precipitation Frequency Data Server (PFDS), which is an interactive web site: (http://hdsc.nws.noaa.gov/hdsc/pfds/).

(b) Rainfall Zones

NOAA Atlas 14 rainfall depths can be quite variable even on a county basis. For example, In Juneau County, Wisconsin, the 100-year, 24-hour NOAA Atlas 14 rainfall depths range from 6.02 to 7.31 inches across the county. In some States, the 24-hour duration rainfall depths vary by more than 1.5 inches across a given county. Those States typically split these counties into rainfall zones. However, in Wisconsin there were no counties where the rainfall depths varied by more than 1.29 inches across the County. Therefore, each Wisconsin county has been assigned a single precipitation value for each storm frequency (1-, 2-, 5-, 10-, 25-, 50- and 100-year) and no Wisconsin county was split into multiple rainfall zones.

(c) Rainfall Distribution Types

The WQQT developed new rainfall distribution types from the NOAA Atlas 14 data for the Midwestern (Volume 8) and the Southeastern (Volume 9) United States. After consultation with the NRCS Wisconsin engineering staff and climate and engineering experts from around Wisconsin, two new NRCS rainfall distribution types were selected for use in Wisconsin. These new NRCS rainfall distributions (MSE3 and MSE4) replace the NRCS Type II storm distribution in Wisconsin. The Type II distribution should not be used with the Wisconsin NOAA Atlas 14 precipitation depths, and the Type II distribution should not be used for Wisconsin hydrologic analysis other than for comparison purposes or in order to recreate an old analysis.

The new Wisconsin NRCS rainfall distribution regions based on data from NOAA Atlas 14 are shown in Figure WI 2-1. The new NRCS rainfall distribution types are also listed, by county, in Appendix 1. The updated rainfall distribution file (**type.rf**) has been developed for use with the EFH-2 computer program. In addition, the new NRCS rainfall distribution types have been included in the WinTR-55 computer program and in the Wisconsin EFH2 and TR55 spreadsheets.

The EFH-2 computer program is unable to use site specific rainfall distribution data. EFH-2 uses equations based on rainfall distribution data to produce the unit peak discharge from time of concentration and excess runoff volume data. The coefficients for these equations were developed by the WQQT for the new rainfall distributions from the NOAA Atlas 14 data. The equations and

coefficients for the two new Wisconsin NRCS rainfall distributions are included in the type.RF file and are described in more detail in Appendix 4 of this Supplement.

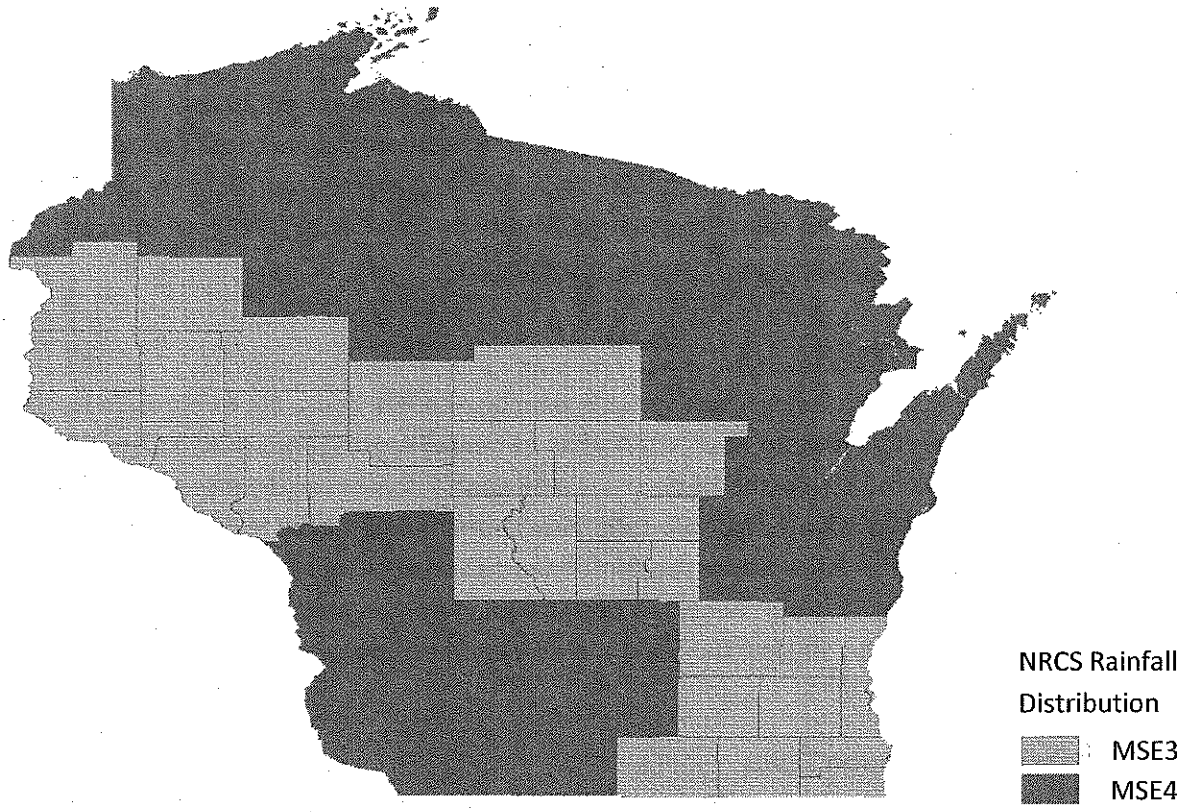


Figure WI 2-1: NRCS Wisconsin Rainfall Distribution Regions based on data from NOAA Atlas 14 Volumes 8 and 9

Appendix 1. New NRCS Rainfall Distributions and 24-hour Duration Rainfall Depths for each Wisconsin County

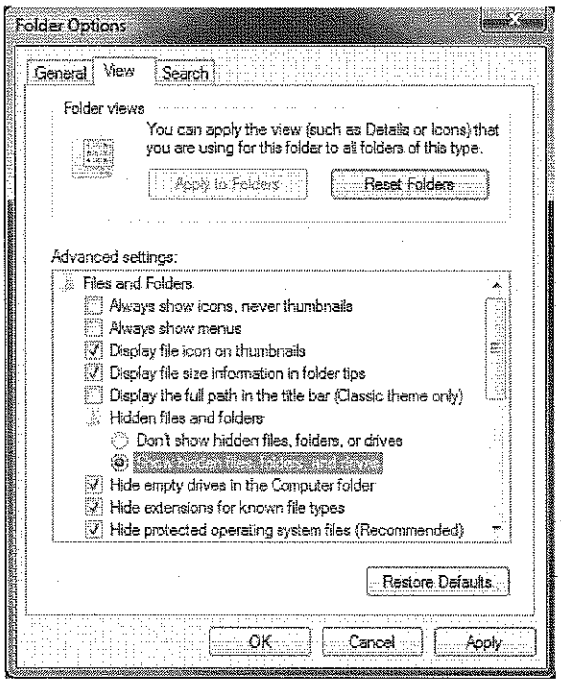
County	NRCS Rainfall Distribution	NOAA Atlas 14 24-Hour Rainfall Depth (Inches)						
		1-year	2-year	5-year	10-year	25-year	50-year	100-year
Adams	MSE3	2.40	2.69	3.26	3.82	4.71	5.50	6.38
Ashland	MSE4	2.38	2.75	3.46	4.15	5.27	6.27	7.37
Barron	MSE3	2.47	2.88	3.57	4.17	5.03	5.72	6.44
Bayfield	MSE4	2.36	2.73	3.45	4.14	5.23	6.18	7.24
Brown	MSE4	2.05	2.37	2.94	3.45	4.22	4.87	5.56
Buffalo	MSE3	2.51	2.90	3.63	4.32	5.39	6.32	7.33
Burnett	MSE4	2.45	2.84	3.52	4.12	5.02	5.76	6.54
Calumet	MSE4	2.14	2.47	3.06	3.60	4.45	5.17	5.96
Chippewa	MSE3	2.40	2.76	3.41	4.00	4.87	5.60	6.38
Clark	MSE3	2.44	2.77	3.37	3.91	4.74	5.44	6.19
Columbia	MSE4	2.43	2.76	3.38	3.96	4.88	5.66	6.52
Crawford	MSE4	2.59	2.94	3.64	4.35	5.50	6.53	7.68
Dane	MSE4	2.49	2.84	3.49	4.09	5.01	5.80	6.66
Dodge	MSE3	2.38	2.68	3.26	3.81	4.67	5.42	6.24
Door	MSE4	2.00	2.31	2.86	3.37	4.14	4.79	5.50
Douglas	MSE4	2.44	2.83	3.52	4.15	5.10	5.90	6.75
Dunn	MSE3	2.44	2.83	3.52	4.15	5.09	5.88	6.73
Eau Claire	MSE3	2.46	2.83	3.49	4.10	5.03	5.81	6.65
Florence	MSE4	2.12	2.40	2.90	3.36	4.05	4.62	5.24
Fond du Lac	MSE4	2.23	2.55	3.13	3.69	4.57	5.33	6.16
Forest	MSE4	2.08	2.38	2.91	3.41	4.17	4.81	5.51
Grant	MSE4	2.68	3.02	3.69	4.38	5.52	6.54	7.69
Green	MSE4	2.58	2.97	3.68	4.34	5.36	6.23	7.18
Green Lake	MSE3	2.29	2.60	3.19	3.74	4.61	5.36	6.18
Iowa	MSE4	2.64	3.03	3.77	4.48	5.58	6.53	7.58
Iron	MSE4	2.37	2.71	3.38	4.05	5.14	6.12	7.21
Jackson	MSE3	2.52	2.85	3.49	4.08	5.02	5.83	6.71
Jefferson	MSE3	2.46	2.79	3.39	3.93	4.75	5.45	6.19
Juneau	MSE3	2.47	2.77	3.38	3.96	4.91	5.74	6.67
Kenosha	MSE3	2.39	2.72	3.30	3.83	4.61	5.26	5.95
Kewaunee	MSE4	2.03	2.37	2.96	3.50	4.30	4.98	5.70
La Crosse	MSE4	2.57	2.94	3.64	4.32	5.37	6.30	7.31
Lafayette	MSE4	2.69	3.06	3.79	4.50	5.64	6.66	7.78
Langlade	MSE4	2.15	2.47	3.03	3.54	4.30	4.94	5.63

County	NRCS Rainfall Distribution	NOAA Atlas 14 24-Hour Rainfall Depth (Inches)						
		1-year	2-year	5-year	10-year	25-year	50-year	100-year
Lincoln	MSE4	2.25	2.60	3.22	3.78	4.62	5.33	6.08
Manitowoc	MSE4	2.11	2.44	3.05	3.62	4.49	5.24	6.06
Marathon	MSE3	2.27	2.61	3.20	3.73	4.51	5.16	5.85
Marinette	MSE4	2.09	2.38	2.88	3.34	4.03	4.61	5.22
Marquette	MSE3	2.37	2.66	3.23	3.79	4.69	5.49	6.38
Menominee	MSE4	2.14	2.45	2.98	3.45	4.15	4.73	5.34
Milwaukee	MSE3	2.34	2.64	3.20	3.73	4.56	5.28	6.06
Monroe	MSE4	2.50	2.83	3.48	4.11	5.11	6.00	6.99
Oconto	MSE4	2.10	2.40	2.93	3.41	4.11	4.70	5.32
Oneida	MSE4	2.20	2.55	3.18	3.76	4.64	5.39	6.19
Outagamie	MSE4	2.14	2.45	3.01	3.51	4.24	4.85	5.50
Ozaukee	MSE3	2.30	2.61	3.20	3.77	4.68	5.49	6.38
Pepin	MSE3	2.51	2.90	3.63	4.32	5.41	6.36	7.39
Pierce	MSE3	2.51	2.87	3.56	4.24	5.33	6.28	7.34
Polk	MSE3	2.48	2.90	3.60	4.22	5.10	5.81	6.55
Portage	MSE3	2.31	2.63	3.19	3.69	4.45	5.08	5.76
Price	MSE4	2.36	2.74	3.41	4.03	4.97	5.77	6.63
Racine	MSE3	2.35	2.67	3.25	3.77	4.55	5.21	5.92
Richland	MSE4	2.57	2.91	3.59	4.29	5.43	6.46	7.62
Rock	MSE3	2.47	2.85	3.52	4.12	5.01	5.76	6.55
Rusk	MSE4	2.38	2.76	3.44	4.03	4.92	5.65	6.42
Sauk	MSE4	2.52	2.86	3.51	4.15	5.18	6.10	7.11
Sawyer	MSE4	2.41	2.80	3.50	4.14	5.11	5.92	6.78
Shawano	MSE4	2.16	2.47	3.01	3.49	4.20	4.78	5.40
Sheboygan	MSE4	2.23	2.57	3.20	3.81	4.75	5.58	6.48
St. Croix	MSE3	2.46	2.82	3.49	4.12	5.10	5.96	6.89
Taylor	MSE4	2.36	2.73	3.38	3.94	4.78	5.46	6.18
Trempealeau	MSE3	2.53	2.93	3.64	4.30	5.31	6.17	7.10
Vernon	MSE4	2.58	2.96	3.68	4.39	5.51	6.50	7.59
Vilas	MSE4	2.22	2.56	3.19	3.79	4.73	5.54	6.43
Walworth	MSE3	2.46	2.80	3.42	3.97	4.80	5.49	6.22
Washburn	MSE4	2.44	2.84	3.53	4.14	5.06	5.82	6.62
Washington	MSE3	2.35	2.65	3.24	3.82	4.73	5.53	6.41
Waukesha	MSE3	2.40	2.70	3.27	3.81	4.66	5.38	6.18
Waupaca	MSE3	2.24	2.55	3.11	3.60	4.32	4.91	5.53
Waushara	MSE3	2.32	2.62	3.17	3.70	4.52	5.22	6.00
Winnebago	MSE4	2.19	2.51	3.09	3.62	4.42	5.10	5.83
Wood	MSE3	2.37	2.68	3.23	3.75	4.54	5.21	5.93

Appendix 2. Instructions for Incorporating Updated Rainfall and Soils Databases into EFH-2 Computer Program in Wisconsin

EFH-2 "Estimating Runoff and Peak Discharge" software requires a rainfall database (**COUNTY.WI**), rainfall distribution types (**type.rf**), and hydrologic soil group database (**SOILS. HG**). These databases are available on the NRCS Wisconsin Engineering website (scroll down to "Engineering Tools" and select "Hydrology, Hydraulics, Climate and Wetland Resources"): (http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/engineering/) and will replace the TP40 based databases. The following describes the steps to use the current databases with the EFH-2 computer program.

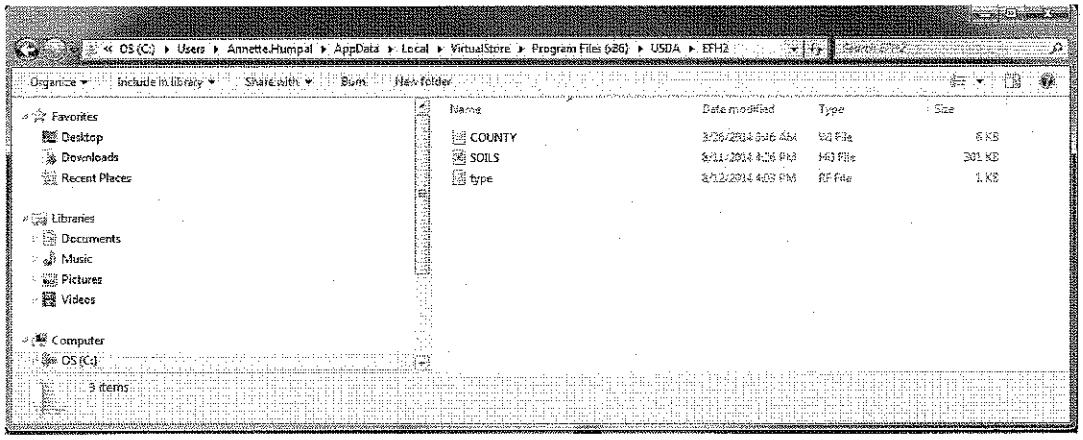
1. In order to use WI Specific data in EFH2, ensure that your computer is set to show hidden files. Click the Windows Start Icon  at the Lower Left corner of your screen. Then select "Control Panel", View by "Category", Select "Appearance and Personalization", "Folder Options", Select the "View" tab, and select the radial button to show hidden files, and select "Apply":



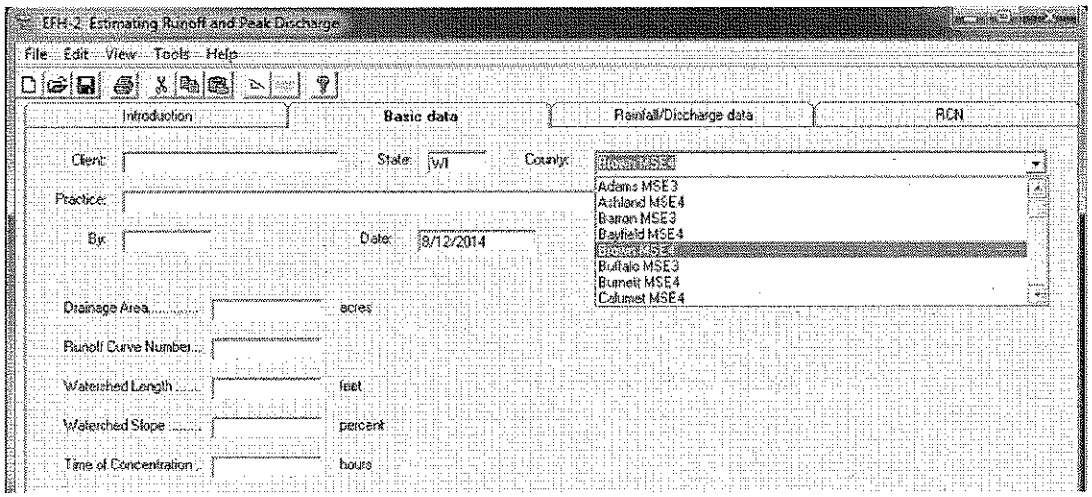
2. Navigate to the EFH-2 Software Updates section of the NRCS Wisconsin Engineering website (from the WI Engineering website given below, scroll down to "Engineering Tools", select "Hydrology, Hydraulics, Climate and Wetland Resources", scroll down to "NRCS National Hydrology Resources", EFH2 Computer Program). http://www.nrcs.usda.gov/wps/portal/nrcs/main/wi/technical/engineering/

3. Click on the EFH-2 files "**COUNTY.WI**", " **type.rf**", and "**SOILS. HG** " and select "Save As" to save these files into the following folder on your computer:
   C:\Users\user.name\AppData\Local\VirtualStore\Program Files (x86)\USDA\EFH2

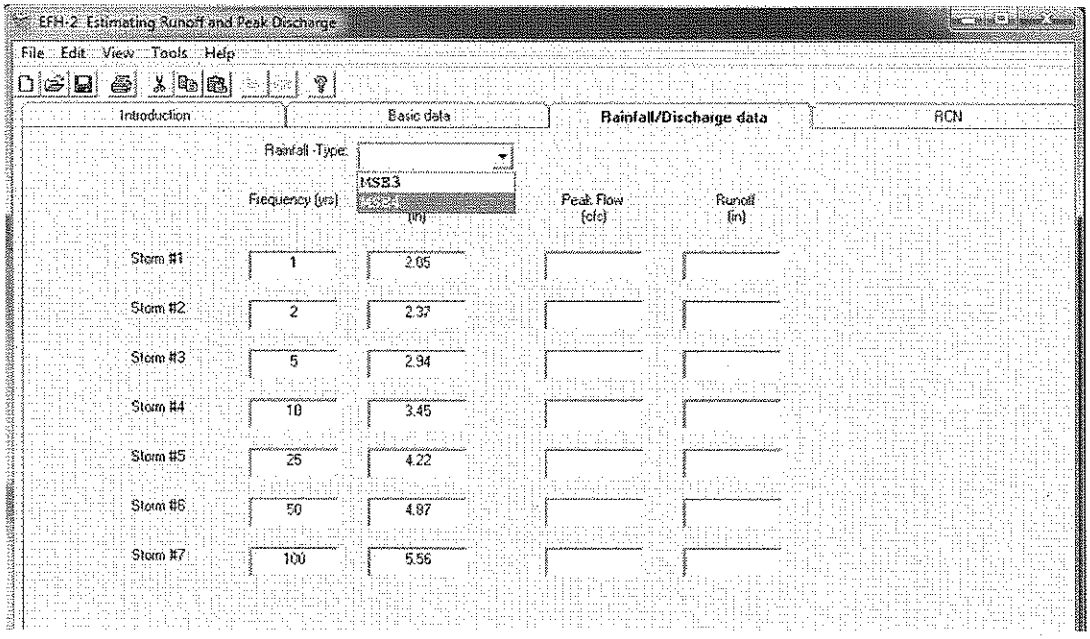
This will replace the existing TP40 based data file. The EFH-2 software now has the NOAA Atlas 14 rainfall depths, rainfall distribution types, and Hydrologic Soil Group database for Wisconsin. **Note** that in some cases you may need to create the folders "USDA" and "EFH2".



4. Open EFH2. Under the Basic Data tab, enter "WI" as the state. Select the applicable County (which also indicates the applicable storm distribution):

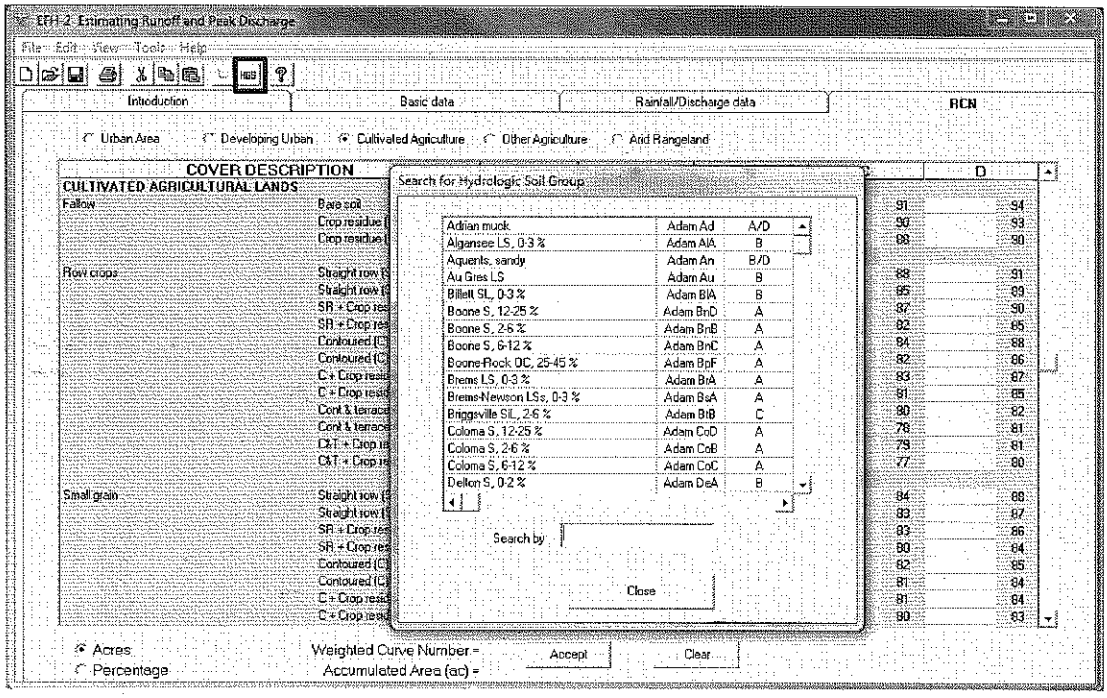


5. Under the Rainfall/Discharge tab, enter the applicable rainfall distribution for the County:



6. EFH-2 will now recognize the WI specific rainfall data and will run the computations.

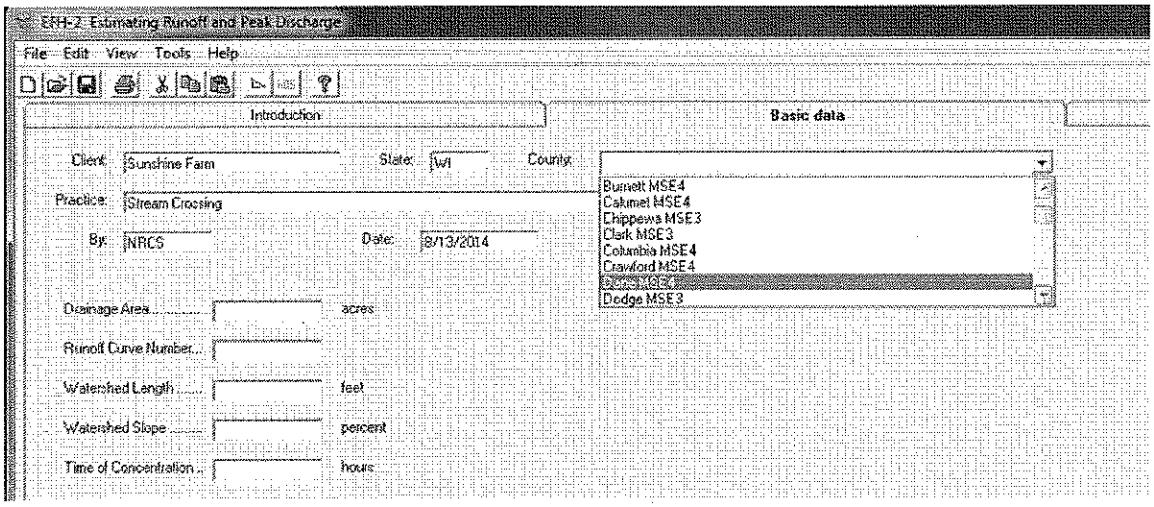
7. Under the RCN tab, click the HSG button and a window will pop up with the "Soil Map Unit Name", "County Abbreviation and Soil Map Unit Symbol" and "Hydrologic Soil Group". This database should be used in lieu of Table 2.1 Hydrologic soil groups for U.S. soil in the Engineering Field Handbook, Chapter 2. County specific hydrologic soil group data is also available upon request to the NRCS WI State Hydraulic Engineer.



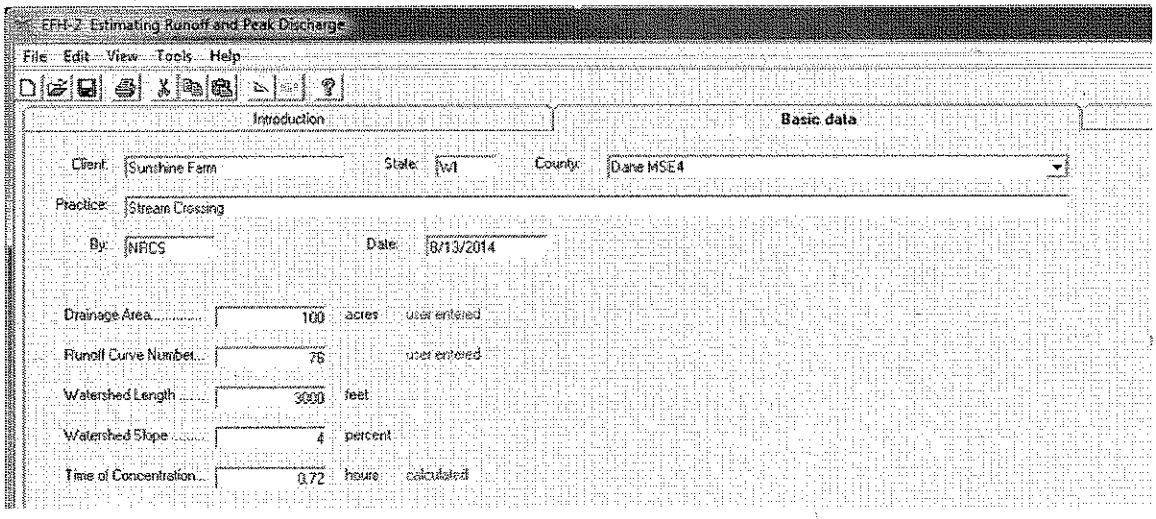
Appendix 3. Example Application of the EFH-2 Computer Program in Wisconsin

For this example, a watershed in Dane County is selected. The drainage area is 100 acres, the curve number is 76, watershed length is 3000 feet, and average watershed slope is 4 percent. From the rainfall distribution map in Figure WI 2-1, the rainfall distribution region is "MSE4".

1. Open the EFH-2 computer program and open the ***Basic Data*** tab. Enter State: WI and use the pull-down menu to select Dane County. The name "MSE4" next to the county name designates this county is in NOAA Rainfall Distribution region MSE4.

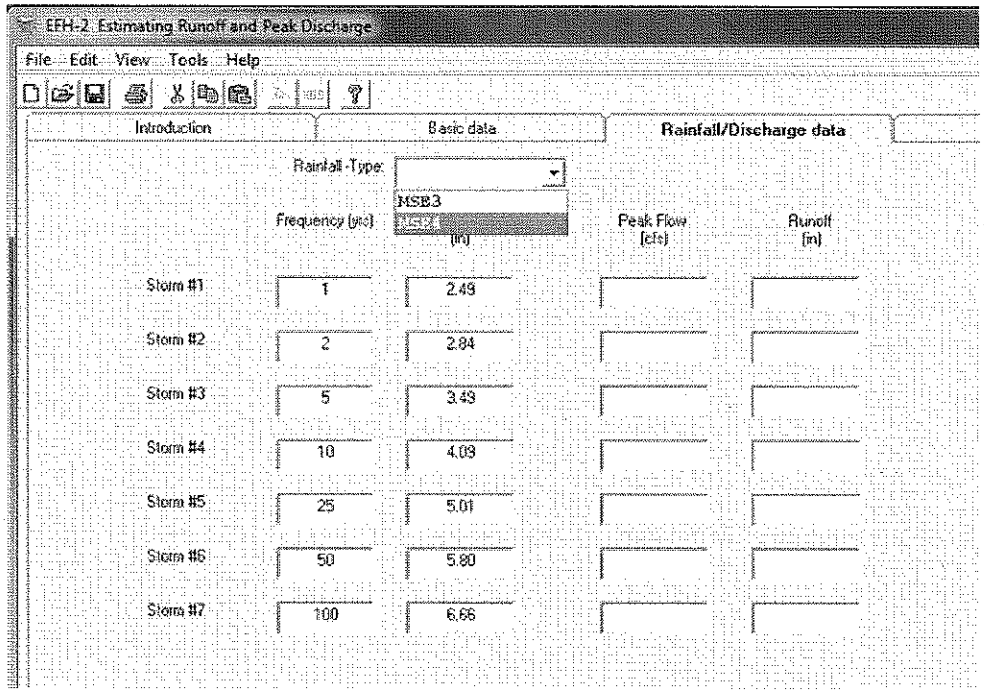


2. Enter the remaining data on this ***Basic Data*** window (curve number, watershed length and watershed slope). Note that when the data is entered directly, "user entered" will appear to the right of the entered data. The Drainage Area and Runoff Curve Number could alternatively be entered by opening the RCN tab (far right tab of EFH-2 window).

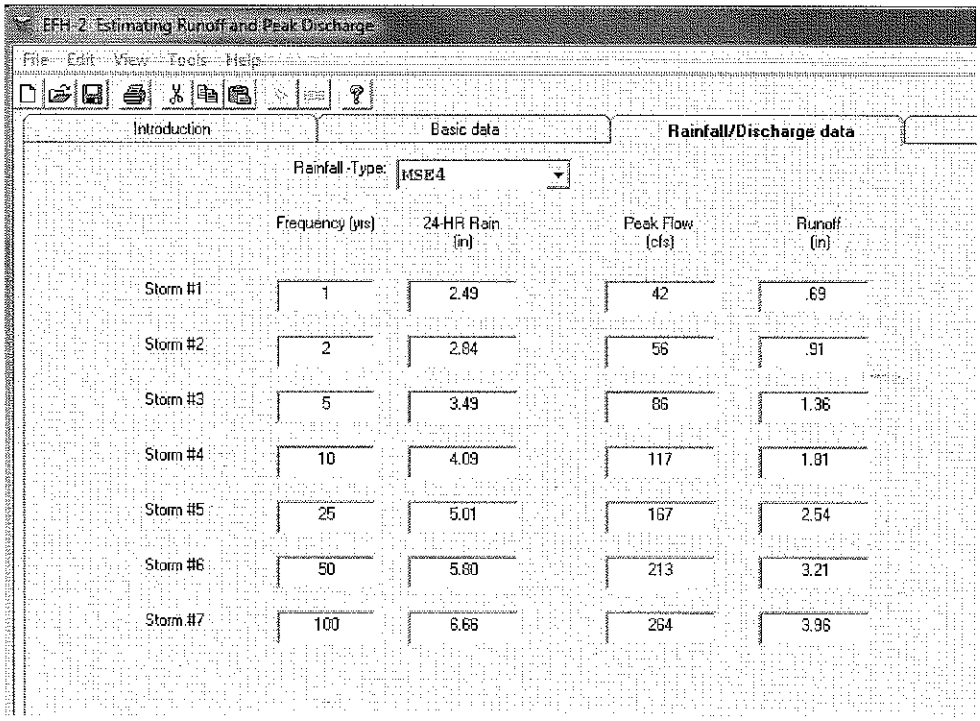


3. Open the Rainfall/Discharge data tab. The 24-hour rainfall data for Dane County has automatically been entered. You may replace these county values with site specific data from http://hdsc.nws.noaa.gov/hdsc/pfds/ if desired. However, this is discouraged, due to the potential spacial variability of the data from the NOAA website. Use the "Rainfall Type" pull-

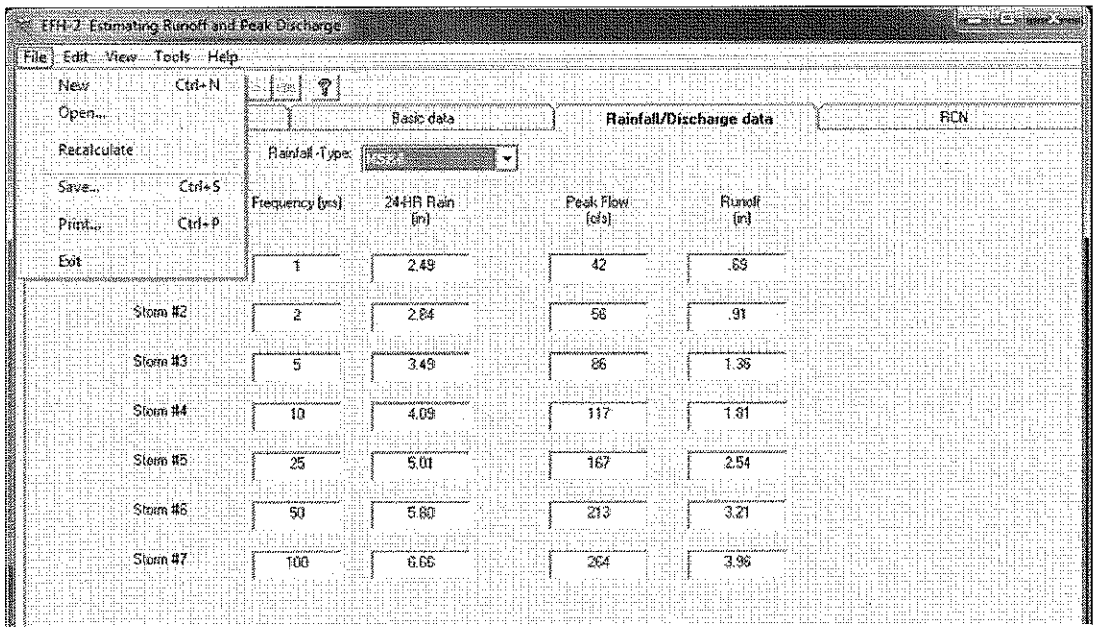
down menu to select the MSE4 distribution which is applicable for Dane County.



4. Upon choosing the rainfall type, the peak discharges and runoff depths are calculated.



5. To complete the project, click File and Save. Print output if desired. Close EFH-2.



Appendix 4. Rainfall Distribution Type Equations, Peak Discharge Curves and Peak Discharge Equation Coefficients

Since the EFH-2 computer program cannot directly use actual rainfall distribution data, alternative methods of estimating peak discharges are needed as described below. Also, since NRCS Type II does not match the NOAA Atlas 14 data, new distribution types and peak flow coefficients were created.

Six rainfall distribution types (MSE1, MSE2, MSE3, MSE4, MSE5 and MSE6) were developed from the NOAA Atlas 14 data to replace the NRCS Type-II rainfall distribution and EFH-2 coefficients. These rainfall distribution types were developed for the 17 States included in the NOAA Atlas 14 Volume 8 (Midwest US) and Volume 9 (Southeast US). Two rainfall distribution types (MSE3 and MSE4) are applicable to Wisconsin.

Peak Equation Coefficients

Rainfall distributions were created for each region and used in WinTR20 models to develop peak flow equation coefficients for use in EFH-2 computer program. To simplify the estimation of peak discharge, WinTR-20 was run for times of concentration of 0.1 to 10.0 hours and I_a/P ratios of 0.1, 0.25, 0.3, 0.4 and 0.5. I_a is initial abstraction in units of inches. Initial abstraction includes all losses before runoff begins (interception, depression storage, early storm infiltration, etc). P is the storm rainfall with units of inches and CN = NRCS runoff curve number.

$$I_a = 0.2 * ((1000 / CN) - 10) \quad \text{Eq. WI A5-1}$$

Equations to relate time of concentration to unit peak discharge were then developed. The equation used to compute the unit peak discharge (q) for the EFH-2 computer program is:

$$q = 10 \wedge (Coeff\_1 + Coeff\_2 * LOG(T_c) + Coeff\_3 * (LOG(T_c))\wedge 2) \quad \text{Eq. WI A5-2}$$

The coefficients to be used with each rainfall distribution are tabulated in Tables A5-1 and A5-2. For example, the equation applicable to the Region MSE3 rainfall distribution region of Wisconsin and I_a/P ratio of 0.1 is:

$$q = 10 \wedge (2.5859 - 0.6447 * LOG(T_c) - 0.1381 * (LOG(T_c))^2) \quad \text{Eq. WI A5-3}$$

For a time of concentration of 0.5 hours and I_a/P ratio of 0.1, the unit peak discharge is q = 585.41 cfs / inch / sq mile. If the drainage area is 200 acres (0.31 square miles) and there is 1.5 inches of runoff, the peak discharge, Q, is:

$$Q = 585.41 * 0.31 * 1.5 = 272 \text{ cfs} \quad \text{Eq. WI A5-4}$$

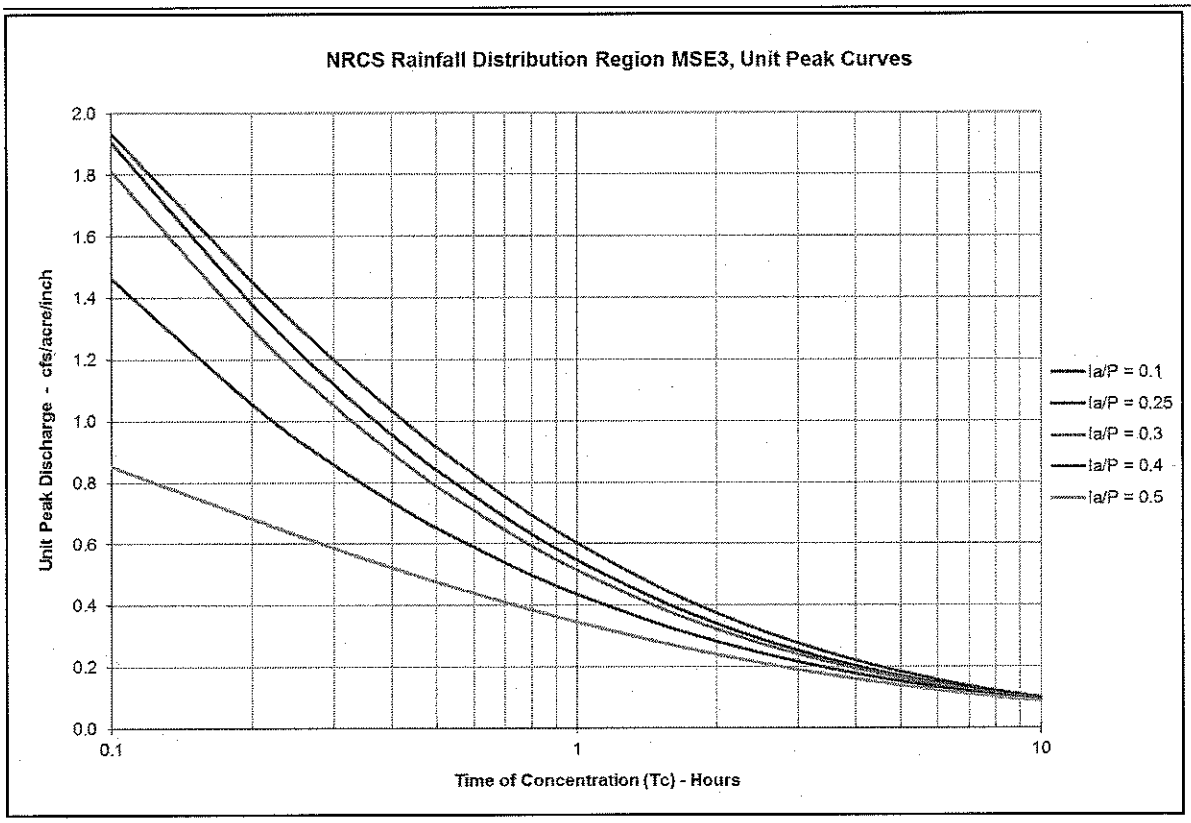


Figure A5-1: EFH-2 Peak Discharge Curves for Rainfall Distribution MSE3

Table A5-1: EFH-2 Peak Discharge Equation Coefficients for Rainfall Distribution MSE3

I_a/P	Coeff_1	Coeff_2	Coeff_3
0.1	2.5859	-0.6447	-0.1381
0.25	2.5440	-0.6528	-0.1105
0.3	2.5172	-0.6453	-0.0982
0.4	2.4454	-0.6035	-0.0776
0.5	2.3440	-0.4950	-0.1025

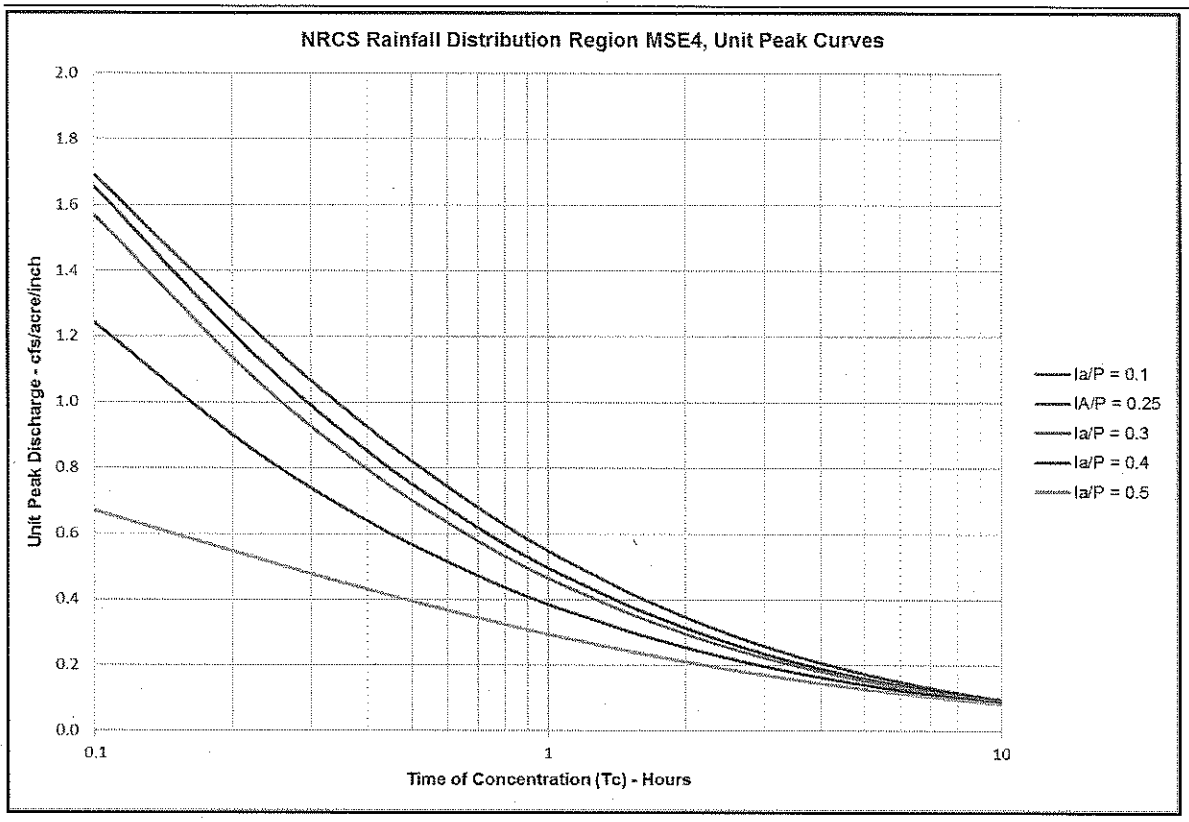


Figure A5-2: EFH-2 Peak Discharge Curves for Rainfall Distribution MSE4

Table A5-2: EFH-2 Peak Discharge Equation Coefficients for Rainfall Distribution MSE4

I_a/P	Coeff_1	Coeff_2	Coeff_3
0.1	2.5447	-0.6222	-0.1332
0.25	2.5016	-0.6298	-0.1071
0.3	2.4730	-0.6226	-0.0947
0.4	2.3917	-0.5773	-0.0694
0.5	2.2743	-0.4524	-0.0948

The following plots in Figure A5-3 are for use with 24-hour design storms. They represent the accumulated rainfall during the 24-hour storm duration on a non-dimensional basis. The maximum accumulated rainfall in the plot is 1.0 which represents the total storm 24-hour rainfall. These rainfall distributions are represented in WinTR-20 in tabular format at a time interval of 0.1 hour.

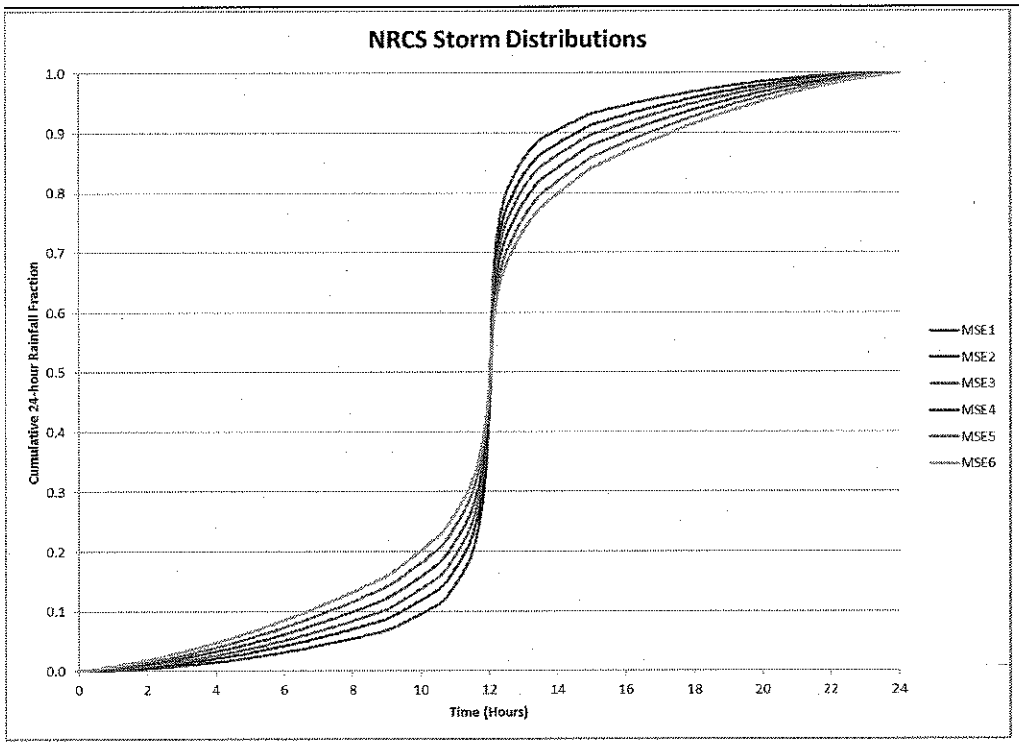


Figure A5-3: Plots of the NRCS Midwest and Southeast states rainfall distributions.